

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/65558 A1

(51) International Patent Classification⁷: **G11B 23/50**

(21) International Application Number: PCT/GB01/00644

(22) International Filing Date: 16 February 2001 (16.02.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0004663.1 29 February 2000 (29.02.2000) GB

(71) Applicant (for all designated States except US): **POLYMER REPROCESSORS LIMITED** [GB/GB]; Polymer House, Admin Road, Knowsley Industrial Park, Merseyside L33 7TZ (GB).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **McCARTHY, Martin** [GB/GB]; Polymer House, Admin Road, Knowsley Industrial Park, Merseyside L33 7TZ (GB).

(74) Agent: **BRANDON, Paul, Laurence**; Appleyard Lees, 15 Clare Road, Halifax, West Yorkshire HX1 2HY (GB).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

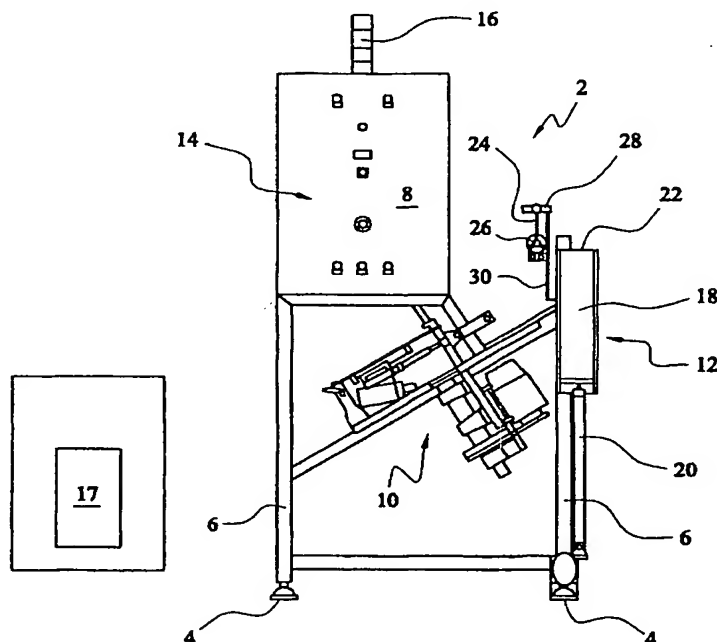
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **DISC HANDLING APPARATUS**



(57) Abstract: The present invention provides a disc handling apparatus comprising a chuck (38) for holding a disc (49), suction means (17, 43) for sucking such a disc onto the chuck and blowing means (17, 43) for blowing such a disc away from the chuck.

WO 01/65558 A1

DISC HANDLING APPARATUS

Field of the Invention

5

The present invention relates to disc handling apparatus and methods, and to associated disc machining apparatus and methods. In particular, but without limitation, the present invention is concerned with apparatus for or for
10 use in apparatus for skimming discs.

Background to the Invention

Compact discs (CDs) are commonplace. They are frequently
15 used for the recording data, sound and images. Currently they are usually a write-once, read-many media. As a result, if not used they become a waste product. To take, for example, the music industry many thousands of CDs are disposed of annually which increases costs and harms the
20 environment. It is desirable therefore to re-process CDs where possible.

A CD is typically made up of a polycarbonate substrate layer bearing an aluminium reflective layer over which is
25 a protective lacquer and finally (optionally) information may be printed on the outer surface (opposite the polycarbonate substrate) of the CD. Typically, a CD is 120mm in diameter and 1.2mm thick circular cylindrical disc.

30

It is desirable to recover in particular the polycarbonate substrate layer without the contamination of the other layers.

It is known to use chemical techniques to etch off the non-polycarbonate layers to retrieve the substrate. However, generally such techniques require heat and
5 moisture resulting in chemical alteration of the polycarbonate material. This is wasteful, potentially harmful to the environment in other ways and reduces the value and usefulness of the resultant polycarbonate material.

10

After processing, generally the polycarbonate material is compounded, blended and pelletised for subsequent re-use.

It is an aim, therefore, of preferred embodiments of the
15 present invention to provide an apparatus and method better suited for and/or for use in the retrieval of polycarbonate from compact discs and other similar products.

20 It is an aim of preferred embodiments of the present invention to provide an improvement over the prior art.

Summary of the Invention

25 According to a first aspect of the present invention, there is provided a disc handling apparatus comprising a chuck for holding a disc, suction means for sucking such a disc on to the chuck and blowing means for blowing such a disc away from the chuck.

30

By providing pneumatic engagement and disengagement for the disc a rapid throughput can be obtained.

Suitably, the chuck is a rotatable chuck.

Suitably, the blowing means comprises a first blowing means arranged to blow the disc away from and above
5 relative to the chuck (ie generally parallel to the axis of rotation of the chuck).

Suitably, the blowing means comprises a second blowing means arranged to blow the disc away from above the chuck.
10 Suitably, the disc is blown generally perpendicular to the axis of rotation of the chuck.

Suitably, the apparatus is arranged sequentially to suck the disc on to the chuck, to blow the disc away from and
15 above the chuck and then to blow the disc away from above the chuck.

Suitably, the sucking means is disengaged prior to the engagement of the means to blow the disc away from the
20 chuck.

Suitably, the sucking means comprises two levels of suction, one greater than the other.

25 Suitably, the apparatus is arranged to suck a disc on to the chuck first with the lower level of suction and later with the increased level of suction. The first lower level of suction helps position and seat the disc. The second greater level of suction secures the disc relative to the
30 chuck.

Suitably, air channels are provided through the chuck to suck and/or blow the disc.

Suitably, the apparatus further comprises a chute for delivery of a disc to the chuck. Suitably, the chute comprises a retractable stop for holding a disc adjacent
5 the chuck.

Suitably, the chute includes means for slowing a disc in the disc's approach to the chuck. Suitably, the slowing means comprises a friction device for engaging the disc
10 and slowing the disc's movement along the chute by friction.

Suitably, the apparatus further comprises an exit slot whereby the apparatus is arranged to blow a disc through
15 the exit slot.

Suitably, a tool is provided to work the disc while it is on the chuck.

20 Suitably, the tool comprises a grinding tool for removing a thickness of the disc. Suitably, the tool is movable forwards and away from the axis of rotation of the chuck. Suitably, the tool is biased towards the chuck. Suitably, the tool is adjustably biased towards the chuck. Suitably,
25 the apparatus further comprises a motor to drive the tool.

Suitably, the apparatus further comprises a disc loading assembly for loading a disc. Suitably, the disc loading assembly comprises a hopper for holding a plurality of
30 discs. Suitably, the hopper comprises a blower for blowing gas at the region of the hopper from which discs are loaded. Such an air source helps separate the discs prior to pick-up and loading.

Suitably, the disc loading assembly further comprises a pick-up assembly for lifting a disc from the top of the hopper, moving the disc to the correct position and
5 depositing the disc. Suitably the pick-up assembly comprises means for engaging the disc by a suction cup. Suitably, the pick-up assembly comprises a rotatable arm.

Suitably, the disc loading assembly further comprises a
10 sensor for detecting when the hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.

Suitably, the disc handling apparatus is suitable for use
15 with compact discs.

According to the present invention in a second aspect, there is provided a method of handling discs, which method comprises the steps of providing a disc, sucking the disc
20 on to a chuck and blowing the disc away from the chuck.

Suitably, the chuck is rotated during the sucking and blowing operations.

25 Suitably, a first blowing means blows the disc away from and above relative to the chuck (ie generally parallel to the axis of rotation of the chuck).

Suitably, a second blowing means blows the disc away from
30 above the chuck. Suitably, the disc is blown generally perpendicular to the axis of rotation of the chuck.

Suitably, the method includes the sequential steps of sucking the disc on to the chuck, blowing the disc away from and above the chuck and then blowing the disc away from above the chuck. Suitably, prior to the disc being
5 blown above the chuck, the sucking is disengaged.

Suitably, the disc is sucked on to the chuck first with a lower level of suction and later with an increased level of suction. The first lower level of suction helps
10 position and seat the disc. The second greater level of suction secures the disc relative to the chuck.

Suitably, there is further provided a chute for delivery of a disc to the chuck. Suitably, the chute comprises a
15 retractable stop for holding a disc adjacent the chuck.

Suitably, the disc is slowed in the disc's approach to the chuck. Suitably, the disc is slowed by a friction device for engaging the disc and slowing the disc's movement
20 along the chute by friction.

Suitably, there is further provided an exit slot through which a disc is blown after processing.

25 Suitably, a tool works the disc while it is on the chuck.

Suitably, the tool comprises a grinding tool which removes a thickness of the disc. Suitably, the tool moves forwards and away from the axis of rotation of the chuck. Suitably,
30 the tool is biased towards the chuck. Suitably, the tool is adjustably biased towards the chuck.

Suitably, there is further provided a disc loading assembly for loading a disc. Suitably, the disc loading assembly comprises a hopper for holding a plurality of discs. Suitably, the hopper comprises a blower which blows
5 gas at the region of the hopper from which discs are loaded. Such an air source helps separate the discs prior to pick-up and loading.

Suitably, there is further provided a pick-up assembly
10 which lifts a disc from the top of the hopper, moves the disc to the correct position and deposits the disc. Suitably the disc is engaged by a suction cup. Suitably, the suction cup is provided on a rotatable arm.

15 Suitably, a sensor detects when the hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.

Suitably, the disc handling assembly is suitable for use
20 with compact discs.

According to the present invention in a third aspect, there is provided a disc machining apparatus comprising a chuck for holding a disc in a disc position, a machining
25 tool, means for rotating such disc relative to the machining tool, and means for driving the machining tool across the disc position, in which the driving means is configured to drive the machining tool at a first speed in a first outer annulus of the disc position and at a second
30 speed (different from the first speed) in a second inner annulus of the disc position, which first speed is lower than the second speed.

By changing the speed at least once the dwell time of the disc can be reduced while maintaining a high quality of machining.

- 5 Suitably, the machining tool is configured initially to start from outside the edge of the disc position and the driving means is configured to drive the tool to the edge of the disc position at a third speed higher than said first or second speeds.

10

Suitably, the machining tool is driven towards the centre of the disc position.

- According to the present invention in a fourth aspect,
15 there is provided a method of machining a disc, the method comprising the steps of: rotating a disc relative to a machining tool, driving the machine tool across the disc, wherein the machine tool is driven at a first speed in a first outer annulus of the disc and that a second speed
20 (different from the first speed) in second inner annulus of the disc, which first speed is lower than the second speed.

- Suitably, the machining tool starts from outside the edge
25 of the disc and the tool is driven to the edge of the disc at a third speed higher than said first or second speeds.

Suitably, the machining tool is driven towards the centre of the disc.

30

According to the present invention in a fifth aspect, there is provided a method of machining compact discs, which method comprises the step of removing at least one

layer from the compact disc by rotating the compact disc relative to a machine tool and using the machine tool to remove the at least one layer.

- 5 The method according to the fifth aspect of the invention can be modified according to any of the preceding aspects of the invention.

Brief Description of Drawings

10

The present invention will now be described, by way of example only, with reference to the drawings that follow; in which:

- 15 Figure 1 is a front view of a skimming apparatus according to the present invention,

Figure 2 is a side view of the skimming apparatus shown in Figure 1,

20

Figure 3 is an enlarged front view of the skimming assembly shown in Figures 1 and 2.

- Figure 4 is an enlarged cut-away plan view of the skimming
25 assembly of Figure 3.

Figures 5a - 5c are a schematic illustrations of a vacuum changeover unit for use with the present invention.

30 Description of the Preferred Embodiments

Referring to the drawings that follow, there is shown a CD skimming apparatus 2 comprising feet 4 acting as the base

of support legs 6 which mount a control unit 8, a CD
skimming assembly 10 and a CD stack and supply unit 12.

The control unit 8 comprises a metal box housing the
5 electronics (primarily a programmable logic controller
("PLC")), the electrical contactors, power supplies, motor
speed controllers and pneumatics for the apparatus. The
front panel of the control unit 8 includes the operator
interface controls indicated generally at 14 including the
10 start/stop buttons and system indicators. Mains electrical
and air supply connections are made to the control panel
via isolators (not shown). Atop the control unit is a
beacon 16 used to alert an operator to various alert
states of the apparatus.

15

A compressor, indicated generally at 17, is provided as a
source for compressed air for pneumatics on the apparatus
as required.

20 The CD stack and supply unit 12 comprises a circular
cylindrical tube hopper 18 defining a hollow space
suitable for receiving up to 400 music CDs (not shown). At
the base of circular cylindrical tube hopper 18 is mounted
a pneumatic ram 20 for driving CDs upwardly towards an
25 opening 22 in the cylindrical tube 18. A pick-up arm 24 is
mounted alongside the circular cylindrical tube 18, which
pick-up arm 24 is mounted at a pivot 26 arranged to rotate
a pneumatic vacuum suction cup 28 between the vertical
position shown in Figures 1 and 2 and generally horizontal
30 position at which point the pneumatic vacuum suction cup
28 contacts the upper surface of a CD in the circular
cylindrical tube 18 (or just proud thereof). Beneath the
pneumatic vacuum suction cup 28 (in its upright vertical

position) is a first CD chute 30 leading to the CD
skimming assembly 10 described in more detail in relation
to Figures 3 and 4. Adjacent the top of the tube 18 are
two sensors 31 arranged to control the upward movement of
5 the stack of CDs, ie to ensure the uppermost CD is
positioned correctly for pick-up. A separate sensor (not
shown) mounted on the pneumatic ram 20 determines when the
stack of CDs is finished.

10 In Figure 3 the CD skimming assembly is shown with its
main plate 32 horizontal, although in use, as can be seen
from Figures 1 and 2, it is mounted at about 30° to the
horizontal to gravity feed the CDs.

15 The CD skimming assembly 10 comprises a second CD chute 34
defined by plate 32 and side walls 36 (only one visible in
Figure 3, the other having been removed for ease of
illustration and explanation). A plastics wiper blade 37
(Figure 3), to provide friction as a CD passes underneath,
20 is mounted over the second CD chute 34. In the main plate
32 is provided a turntable in the form of a pneumatic
chuck 38 mounted on an axle 40 in a running joint 42. The
pneumatic chuck 38 has a plurality of holes 39
therethrough through which pneumatic pressure (blow) and
25 vacuum (suck) can be provided to a CD on the chuck 38 from
a vacuum changeover unit indicated schematically at 43,
further details of which are given below. The axle 40 is
further supported by pillow-box supports 44 and is driven
by a spindle motor 46.

30

A retractable stop 47 comprising a pneumatically driven
finger is mounted beneath the second CD chute 34 just
before the chuck 38. The stop 47 can protrude into the

pathway of the second CD chute 34 to block the passage of a CD on to the chuck 38 and be withdrawn to permit passage. A CD 49 is shown held by the stop 47.

- 5 The main plate 32 carries a first support block 48 and a second support block 50 which between them mount a linear slide assembly 52, which includes a support arm 54.

A cutting device 58 is pivotally mounted on support arm
10 54. The cutting device 58 comprises a spindle motor 60 driving a tungsten carbide rotary cutting tool 62. The linear slide assembly 52 is driven by a traverse pneumatic cylinder 56 arranged to drive the cutting device 58 towards and away from pneumatic chuck 38. The cutting
15 device 58 is adjustably biased towards the main plate 32 by a depth of cut cylinder 64.

Adjacent the chuck 38 is an exit slot 66 in side walls 32 of second CD chute 34, which exit slot 66 leads to a
20 collection bin (not shown). An air knife 68 is provided adjacent the chuck 38 on the side opposite the exit slot 66.

In use a hopper 18 full of CDs 49 is inserted as shown and
25 the apparatus actuated with the coated surface of the polycarbonate substrate of the CD uppermost. While the apparatus 2 is in operation, the chuck 38 is continuously rotated by spindle motor 46 and the cutting tool 62 is continuously driven by spindle motor 60.

30

Pneumatic ram 20 drives the stack of CDs upward towards opening 22. The presence of an upper CD is registered by sensors 31 and the pick-up arm 24 is actuated to rotate

its vacuum suction cup 28 to engage the upper surface of the upper CD (which at this point is generally horizontal). In the hopper 18 an air jet (indicated schematically at 19) is blown at the top few (typically
5 three) CDs from compressor 17 which encourages separation between the CDs so that when the top CD is picked up, it releases cleanly from the next CD in the stack.

The pick-up arm 24 rotates about pivot 26 to bring the CD
10 roughly to the vertical, at which point the suction on suction-cup 28 is disengaged to release the CD in to first CD chute 30 which guides the CD to second CD chute 34. The wiper blade 37 slows the progress of the CD as it reaches stop 47. (This is the position shown in Figure 4). A
15 sensor (not shown) registers the successful ejection of a preceding CD and when the chuck 38 is free the stop 47 is retracted releasing the CD in to the remaining part of second CD chute 34 to chuck 38 by a gravity feed.

20 As the CD is released from the stop 47 to the chuck 38, the CD stack and supply unit 12 is actuated to provide another CD. Thus while the apparatus is machining a CD on the chuck 38 a further CD is waiting behind stop 47 ready to be delivered to chuck 38 as soon as the preceding CD
25 has cleared the chuck 38 of 875 revolutions per minute (rpm).

As a CD arrives at chuck 38 the vacuum changeover unit provides low vacuum to assist seating of the CD on the
30 chuck 38. Full vacuum is then engaged to locate and clamp the CD to the rotating chuck 38. The gradationally increased vacuum ensures the CD locates on the chuck 38 and is quickly up to the chuck speed.

Once full vacuum has been engaged, the cutting device 58 is driven towards the CD substantially on a radius thereof by traverse pneumatic cylinder 56. The cutting device 58 is driven from a home position spaced from the CD to the edge of the CD at maximum speed. Once the cutting device reaches the edge of the CD it proceeds from the edge of the CD to 15mm in from the edge at a slow speed to allow the cutting tool 62 to mount the CD and to cut the first and fastest moving annulus of the CD. After the first 15mm the speed is increased to a higher speed to complete the stroke of the cutting device 58 to just beyond the nominal centre-point of the CD on chuck 38. The higher speed is intermediate the slow speed and the maximum speed. The cutting device 58 is then driven to its home position at maximum speed.

The cutting tool 62 rotates at 23,000 rpm to machine away a depth of the CD to skim off the metallic, lacquer and print (if present) layers leaving just the polycarbonate substrate for subsequent reprocessing.

Once the cutting tool 62 is clear of the disc, the vacuum changeover unit 43 switches to full blow to release the CD from the chuck 38 and to lift it up away from the surface of the chuck 38 by a few millimetres. Air knife 68 is then engaged to blow the CD in a direction generally perpendicular to the axis of rotation of the chuck 38 through exit slot 66 (see CD 49a in Figure 4)), to the collection bin (not shown). A sensor (not shown) monitors the ejected CD as it exits. A non-ejection event suspends the sequence and places the apparatus in to an alarm condition.

The next CD waiting on second CD chute 34 is released by stop 47 on to the chuck 38 to repeat the process, until the hopper 18 is empty at which point the apparatus stops
5 and enters an alarm state waiting for the hopper 18 to be re-filled.

The entire sequence from release by the stop 47 to ejection from the chuck 38 after machining takes
10 approximately 3.5 seconds.

To adjust the cutting depth of the tool 62, the depth of cut cylinder 64 is adjusted to increase (for a deeper cut) or decrease (for a shallower cut) the bias of the tool 62
15 towards the CD.

A plurality of such apparatus may be provided in which case a conveyor (not shown) can be provided to receive ejected CDs for delivery to a common collection bin (not
20 shown).

Referring to Figures 5a - 5c of the drawings that follow, the vacuum changeover unit 43 is illustrated in three different modes of operation and includes a vac/blow motor
25 as indicated schematically at 101.

Referring to 5a of the drawings that follow (Figures 5b and 5c are similar, but in a different configuration), the vacuum changeover unit has a blow inlet 100 from a blow
30 outlet 102 of vac/blow motor 101 and a vacuum (or suction inlet 104 from the suction outlet 106 of vac/blow motor 101).

Also provided is a pneumatic connection 108 to the chuck 38.

5 The changeover unit 43 comprises a first valve 110 adjacent the suction inlet 106 and a second valve 112 adjacent the blow inlet 100. The first valve 110 comprises a first piston 114 that can be retracted (Figures 5a and 5c) or extended (Figure 5b) position according to its pneumatic control.

10

The second valve 112 comprises a second piston 116 that can be retracted (Figure 5c) or extended (Figures 5a and 5b) according to its pneumatic control.

15 In the retracted position of first piston 114 the suction inlet 104 and therefore the pneumatic chuck connection 108 are in fluid communication with atmosphere; and the blow inlet 100 may be to atmosphere dependent on the position of second piston 116. In the extended position of second
20 piston 116 the blow inlet 100 is blocked off from the suction inlet 104 and pneumatic chuck connection 108, while in the retracted position of second piston 116 the blow inlet 100 is in fluid communication with both the suction inlet 104 and the pneumatic chuck connection 108.
25 The blow inlet 100 is placed in the region of the stroke of second piston 116.

In use the chuck 38 requires three modes: partial suction (Figure 5a) used to initially locate the CD 49 on the
30 chuck 38; full suction (Figure 5b) used to locate and secure the CD 49 on the chuck 38; and full blow (Figure 5c) to release the CD 49 from the chuck 38 to enable

ejection of the CD49 which are achieved as follow, the letters referring to the Figures 5a - 5c.

By retracting the second piston 116 a bleed to atmosphere
5 is provided to diminish the reduced pressure effect of the suction.

Other pneumatic arrangements can be used, but currently this is preferred due to its simplicity, minimal number of
10 moving parts and reliance on a minimum number of compressors/air sources.

The preferred embodiments of the present invention can be used for other similar discs such as Digital Versatile
15 Discs ("DVD's"), also referred to as Digital Video Discs. It can even be used for double-sided DVD's by grinding of a polycarbonate layer and the sandwiched metallic and lacquer layers to leave a polycarbonate substrate. In the appended claims, the term "compact disc" is used to
20 indicate DVDs and other like products including CD-ROMs, Enhanced CDs, CD-Rs, CD-RWs, Photo CDs and Super Audio CDs all of which have a substrate material with unwanted layers coated thereon.

25 The apparatus described herein is mainly intended for circular cylindrical discs, but it is not limited thereto.

Thus, embodiments of the present invention provide a disc handling apparatus and a corresponding method of handling
30 discs, together with a disc machining apparatus and method of machining discs.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this
5 specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and
10 drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

15 Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each
20 feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel
25 one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A disc handling apparatus comprising a chuck for holding a disc, suction means for sucking such a disc
5 on to the chuck and blowing means for blowing such a disc away from the chuck.
2. A disc handling apparatus according to claim 1, in which the chuck is a rotatable chuck.
- 10 3. A disc handling apparatus according to claim 1 or claim 2, in which the blowing means comprises a first blowing means arranged to blow the disc away from and above relative to the chuck (ie generally parallel to
15 the axis of rotation of the chuck).
4. A disc handling apparatus according to any preceding claim, in which the blowing means comprises a second blowing means arranged to blow the disc away from
20 above the chuck.
5. A disc handling apparatus according to claim 4, in which the disc is blown generally perpendicular to the axis of rotation of the chuck.
- 25 6. A disc handling apparatus according to any preceding claim, in which the apparatus is arranged sequentially to suck the disc on to the chuck, to blow the disc away from and above the chuck and then to blow the
30 disc away from above the chuck.
7. A disc handling apparatus according to any preceding claim, in which the sucking means is disengaged prior

to the engagement of the means to blow the disc away from the chuck.

8. A disc handling apparatus according to any preceding
5 claim, in which the sucking means comprises two levels of suction, one greater than the other.

9. A disc handling apparatus according to claim 8, in
10 which the apparatus is arranged to suck a disc on to the chuck first with the lower level of suction and later with the increased level of suction.

10. A disc handling apparatus according to any preceding
15 claim, in which air channels are provided through the chuck to suck and/or blow the disc.

11. A disc handling apparatus according to any preceding
20 claim, in which the apparatus further comprises a chute for delivery of a disc to the chuck.

12. A disc handling apparatus according to claim 11, in
which the chute comprises a retractable stop for holding a disc adjacent the chuck.

25 13. A disc handling apparatus according to claim 11 or claim 12, in which the chute includes means for slowing a disc in the disc's approach to the chuck.

30 14. A disc handling apparatus according to claim 13, in which the slowing means comprises a friction device for engaging the disc and slowing the disc's movement along the chute by friction.

15. A disc handling apparatus according to any preceding claim, in which the apparatus further comprises an exit slot whereby the apparatus is arranged to blow a disc through the exit slot.
- 5
16. A disc handling apparatus according to any preceding claim, in which a tool is provided to work the disc while it is on the chuck.
- 10
17. A disc handling apparatus according to claim 16, in which the tool comprises a grinding tool for removing a thickness of the disc.
18. A disc handling apparatus according to claim 16 or
15 claim 17, in which the tool is movable forwards and away from the axis of rotation of the chuck.
19. A disc handling apparatus according to any one of claims 16 to 18, in which the tool is biased towards
20 the chuck.
20. A disc handling apparatus according to claim 19, in which the tool is adjustably biased towards the chuck.
- 25
21. A disc handling apparatus according to any one of claims 16 to 20, in which the apparatus further comprises a motor to drive the tool.
22. A disc handling apparatus according to any preceding
30 claim, in which the apparatus further comprises a disc loading assembly for loading a disc.

23. A disc handling apparatus according to claim 22, in which the disc loading assembly comprises a hopper for holding a plurality of discs.
- 5 24. A disc handling apparatus according to claim 23, in which the hopper comprises a blower for blowing gas at the region of the hopper from which discs are loaded.
- 10 25. A disc handling apparatus according to claim 23, in which the disc loading assembly further comprises a pick-up assembly for lifting a disc from the top of the hopper, moving the disc to the correct position and depositing the disc.
- 15 26. A disc handling apparatus according to claim 25, in which the pick-up assembly comprises means for engaging the disc by a suction cup.
- 20 27. A disc handling apparatus according to claim 25 or claim 26, in which the pick-up assembly comprises a rotatable arm.
- 25 28. A disc handling apparatus according to claim 23, in which the disc loading assembly further comprises a sensor for detecting when the hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.
- 30 29. A disc handling apparatus according to any preceding claim, in which the disc handling apparatus is suitable for use with compact discs.

30. A method of handling discs, which method comprises the steps of providing a disc, sucking the disc on to a chuck and blowing the disc away from the chuck.
- 5 31. A method of handling discs according to claim 31, in which the chuck is rotated during the sucking and blowing operations.
- 10 32. A method of handling discs according to claim 30 or claim 31, in which a first blowing means blows the disc away from and above relative to the chuck (ie generally parallel to the axis of rotation of the chuck).
- 15 33. A method of handling discs according to any one of claims 30 to 32, in which a second blowing means blows the disc away from above the chuck.
- 20 34. A method of handling discs according to claim 33, in which the disc is blown generally perpendicular to the axis of rotation of the chuck.
- 25 35. A method of handling discs according to any one of claims 30 to 34, in which the method includes the sequential steps of sucking the disc on to the chuck, blowing the disc away from and above the chuck and then blowing the disc away from above the chuck.
- 30 36. A method of handling discs according to claim 35, in which prior to the disc being blown above the chuck, the sucking is disengaged.

37. A method of handling discs according to any one of claims 30 to 36, in which the disc is sucked on to the chuck first with a lower level of suction and later with an increased level of suction.
- 5 38. A method of handling discs according to any one of claims 30 to 37, in which there is further provided a chute for delivery of a disc to the chuck.
- 10 39. A method of handling discs according to claim 38, in which the chute comprises a retractable stop for holding a disc adjacent the chuck.
- 15 40. A method of handling discs according to claim 38 or claim 39, in which the disc is slowed in the disc's approach to the chuck.
- 20 41. A method of handling discs according to claim 40, in which the disc is slowed by a friction device for engaging the disc and slowing the disc's movement along the chute by friction.
- 25 42. A method of handling discs according to any one of claims 30 to 41, in which there is further provided and exit slot through which a disc is blown after processing.
- 30 43. A method of handling discs according to any one of claims 30 to 42, in which a tool works the disc while it is on the chuck.

44. A method of handling discs according to claim 43, in which the tool comprises a grinding tool which removes a thickness of the disc.
- 5 45. A method of handling discs according to claim 43 or claim 44, in which the tool moves forwards and away from the axis of rotation of the chuck.
- 10 46. A method of handling discs according to any one of claims 43 to 45, in which the tool is biased towards the chuck.
47. A method of handling discs according to claim 46, in which the tool is adjustably biased towards the chuck.
- 15 48. A method of handling discs according to any one of claims 30 to 47, in which there is further provided a disc loading assembly for loading a disc.
- 20 49. A method of handling discs according to claim 48, in which the disc loading assembly comprises a hopper for holding a plurality of discs.
- 25 50. A method of handling discs according to claim 49, in which the hopper comprises a blower which blows gas at the region of the hopper from which discs are loaded.
- 30 51. A method of handling discs according to claim 49 or claim 50, in which there is further provided a pick-up assembly which lifts a disc from the top of the hopper, moves the disc to the correct position and deposits the disc.

52. A method of handling discs according to any one of claims 49 to 51, in which the disc is engaged by a suction cup.
- 5 53. A method of handling discs according to claim 52, in which the suction cup is provided on a rotatable arm.
54. A method of handling discs according to any one of claims 49 to 53, in which a sensor detects when the
10 hopper is empty, which detector is arranged with a controller to generate an alert signal upon detecting that the hopper is empty.
55. A method of handling discs according to any one of
15 claims 49 to 54, in which the disc handling assembly is suitable for use with compact discs.
56. A disc machining apparatus comprising a chuck for holding a disc in a disc position, a machining tool,
20 means for rotating such disc relative to the machining tool, and means for driving the machining tool across the disc position, in which the driving means is configured to drive the machining tool at a first speed in a first outer annulus of the disc position
25 and at a second speed (different from the first speed) in a second inner annulus of the disc position, which first speed is lower than the second speed.
57. A disc machining apparatus according to claim 56, in
30 which the machining tool is configured initially to start from outside the edge of the disc position and the driving means is configured to drive the tool to

the edge of the disc position at a third speed higher than said first or second speeds.

58. A disc machining apparatus according to claim 56 or
5 claim 57, in which the machining tool is driven towards the centre of the disc position.

59. A method of machining a disc, the method comprising
the steps of: rotating a disc relative to a machining
10 tool, driving the machine tool across the disc, wherein the machine tool is driven at a first speed in a first outer annulus of the disc and that a second speed (different from the first speed) in second inner annulus of the disc, which first speed is lower than
15 the second speed.

60. A method of machining a disc according to claim 59, in which the machining tool starts from outside the edge of the disc and the tool is driven to the edge of the
20 disc at a third speed higher than said first or second speeds.

61. A method of machining a disc according to claim 59 or
claim 60, in which the machining tool is driven
25 towards the centre of the disc.

62. A method of machining compact discs, which method comprises the step of removing at least one layer from the compact disc by rotating the compact disc relative
30 to a machine tool and using the machine tool to remove the at least one layer.

63. A method of machining compact discs, in which the disc handling apparatus is according to any one of claims 1 to 29, the method of handling discs is according to any one of claims 30 to 55, the disc machining apparatus is according to claim 56 and/or the method is according to any one of claims 57 to 62.

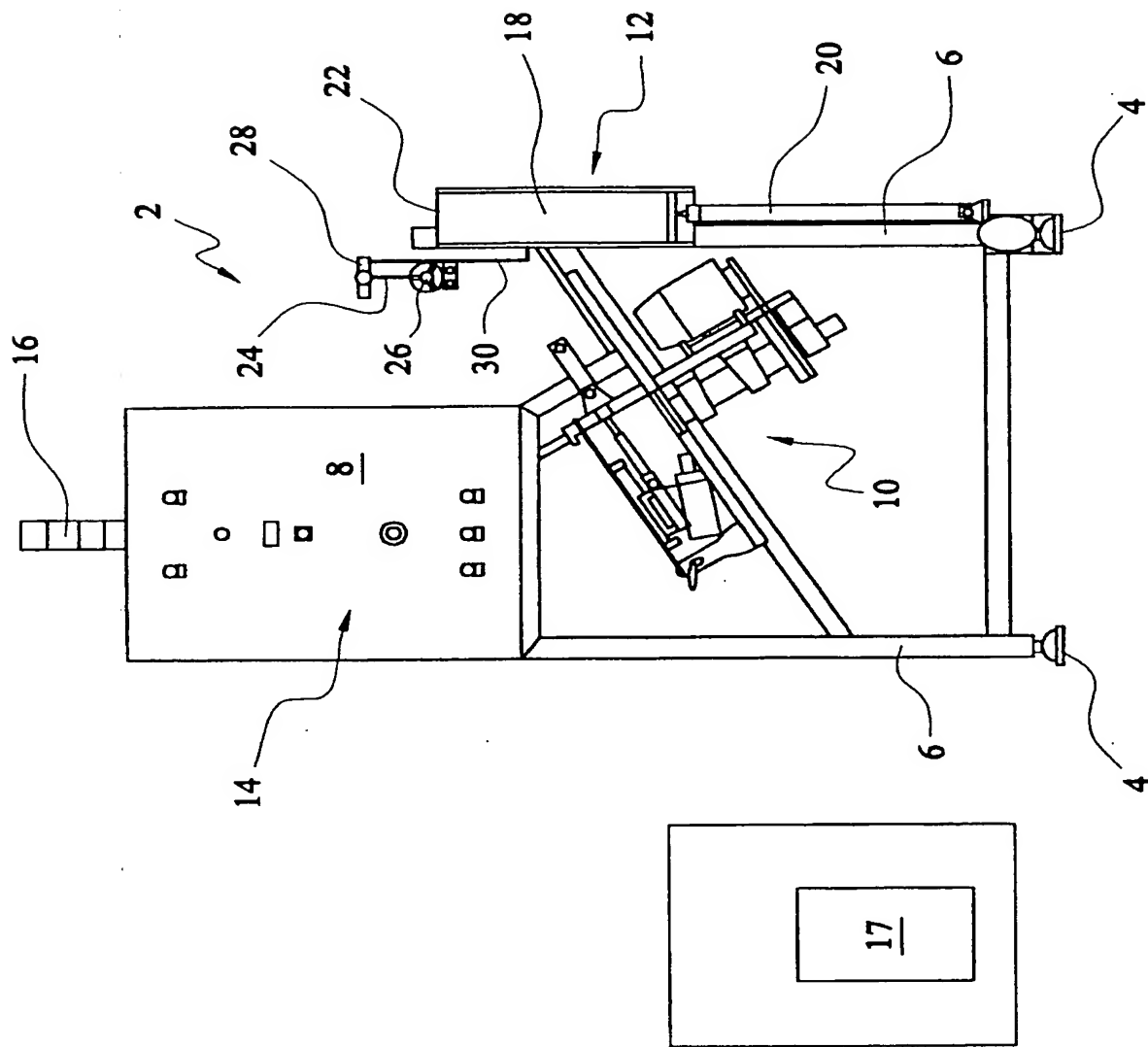
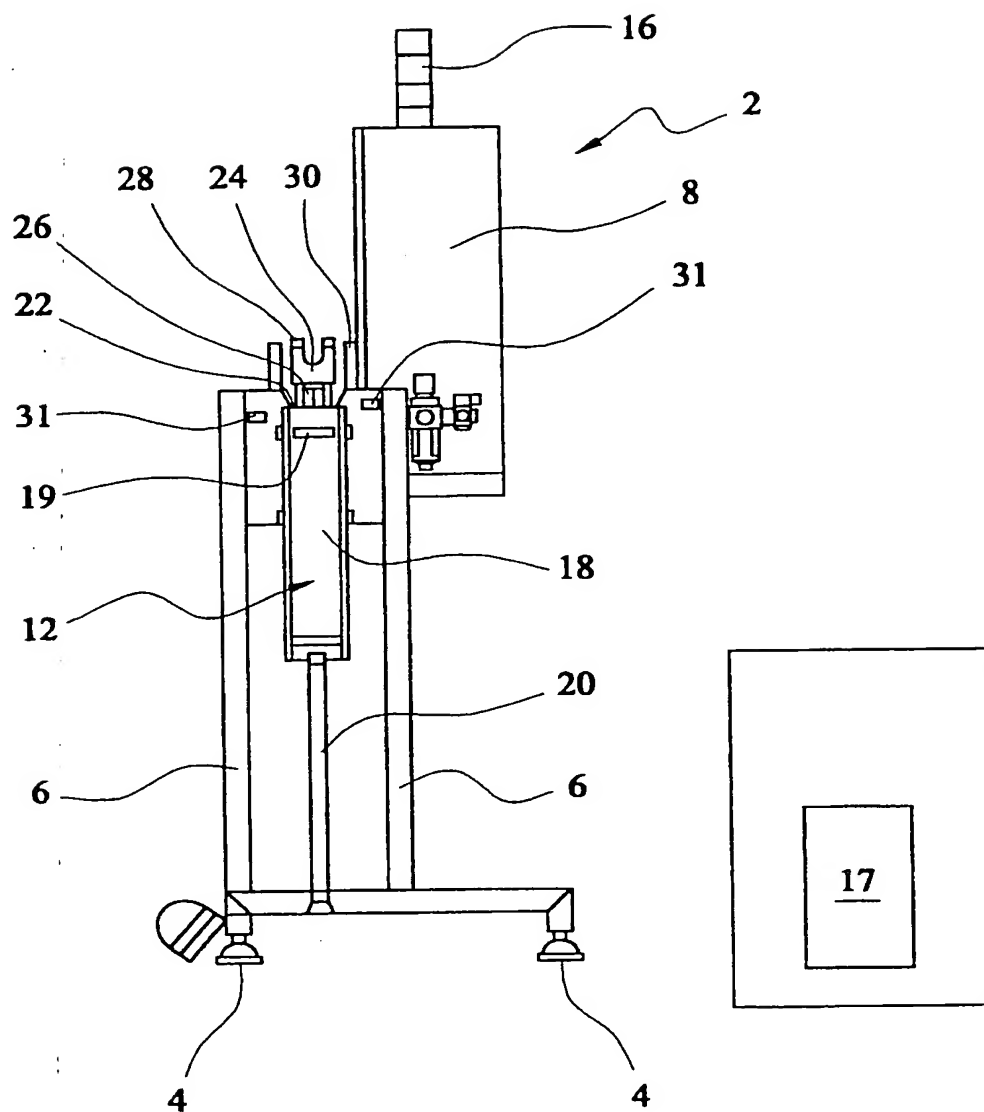


FIG. 1

-2/5-

FIG. 2

-3/5-

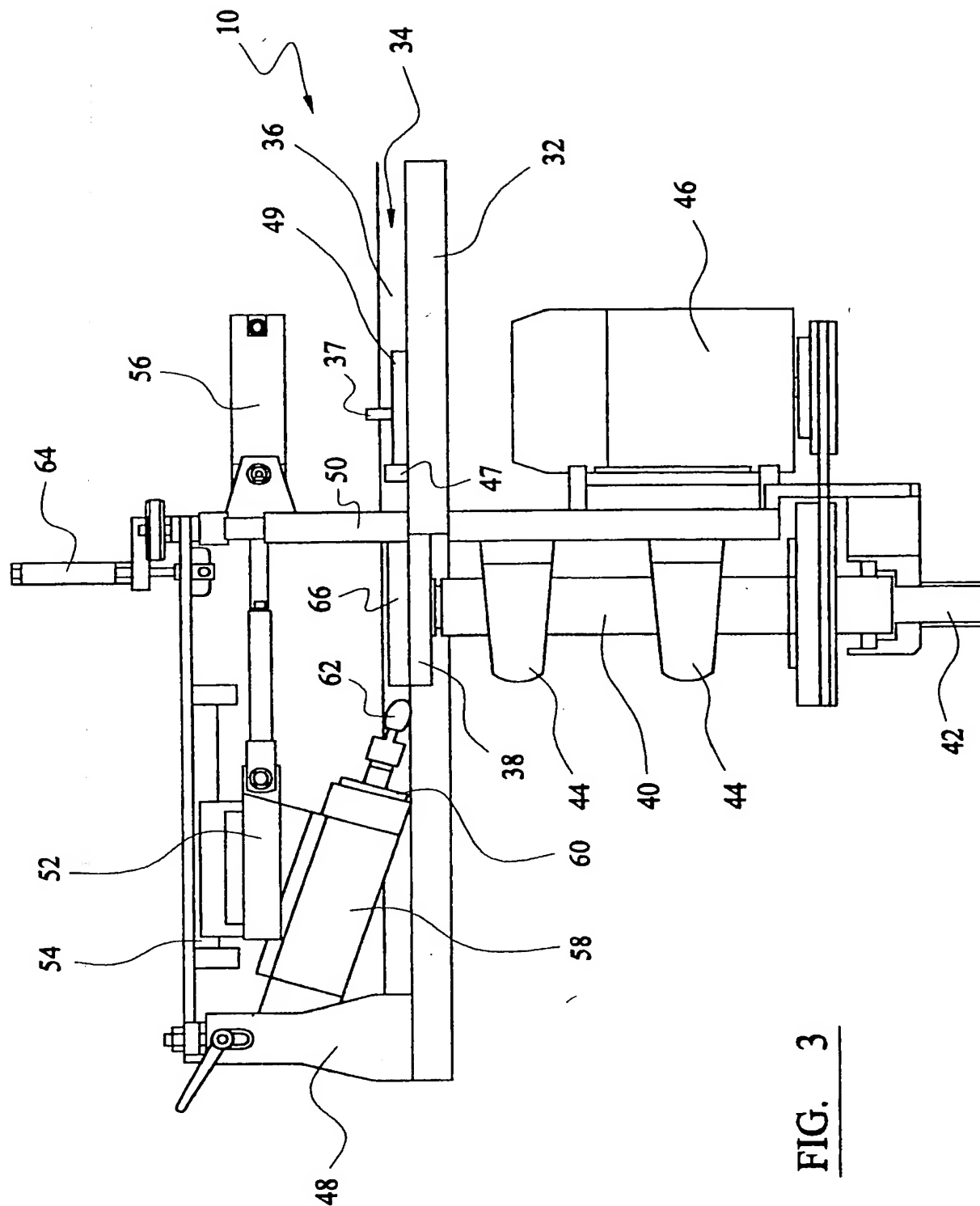


FIG. 3

4/5-

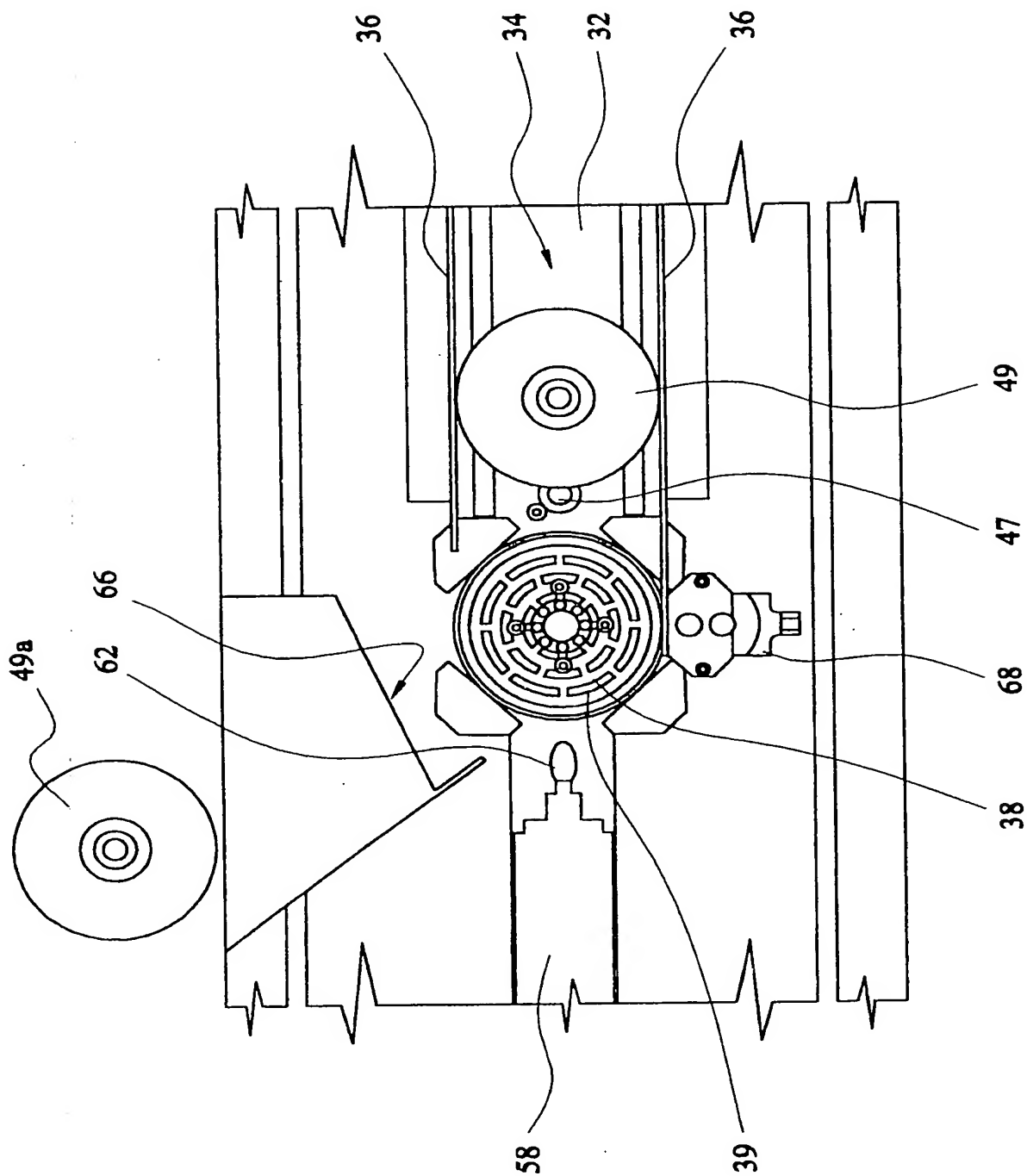


FIG. 4

-5/5-

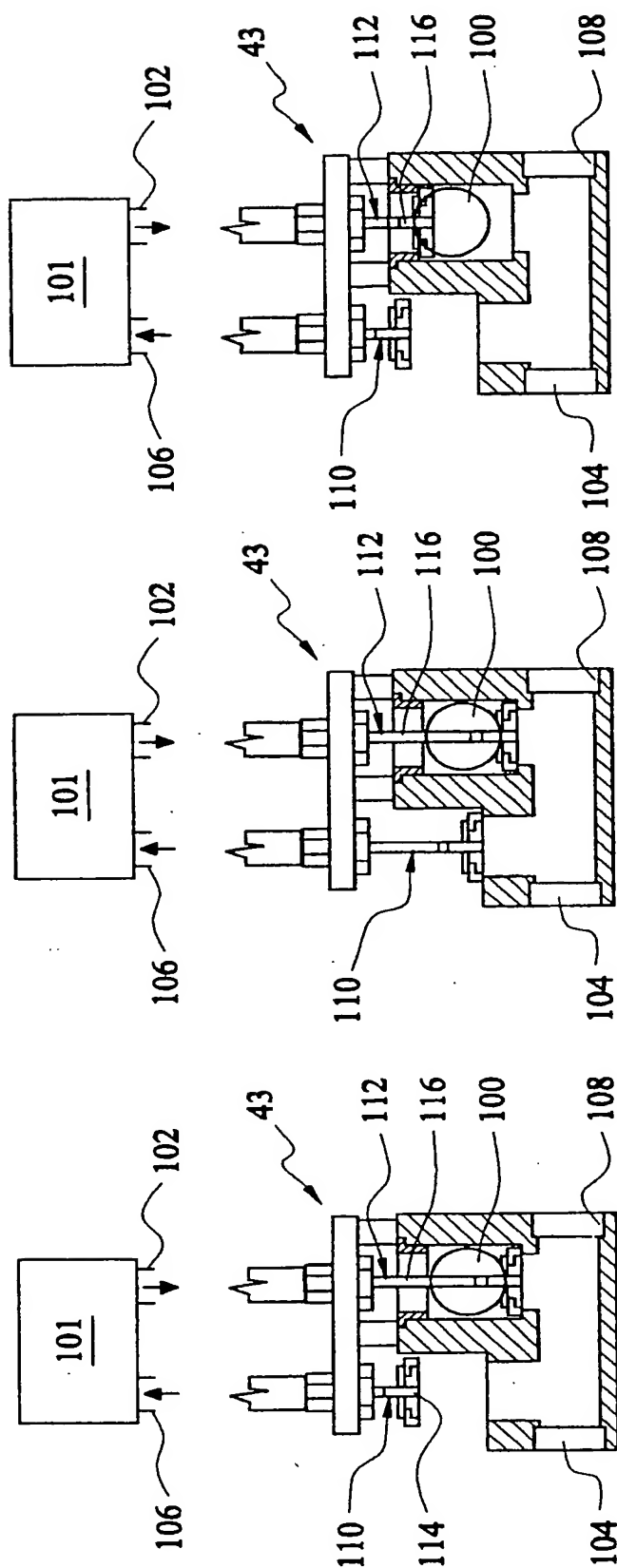


FIG. 5a

FIG. 5b

FIG. 5c

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 01/00644

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G11B23/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 220 754 A (TAYEBI AMAD ET AL) 22 June 1993 (1993-06-22) the whole document ---	1-63
X	DE 43 40 595 A (LEGNER ECKHARDT ; RHABEK WALTER OTTO (DE); STROMMER CHRISTIAN (AT);) 1 June 1995 (1995-06-01) the whole document ---	1-63
X	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 04, 31 March 1998 (1998-03-31) -& JP 09 309066 A (KAO CORP), 2 December 1997 (1997-12-02) abstract; figures --- -/-	1-63



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

18 June 2001

Date of mailing of the international search report

27/06/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Declat, M

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 01/00644

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 619 898 A (WITT GEORG) 15 April 1997 (1997-04-15) the whole document ----	1-63
A	EP 0 794 528 A (KOMAG INC) 10 September 1997 (1997-09-10) the whole document ----	1-63
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 09, 31 July 1998 (1998-07-31) -& JP 10 109241 A (KAO CORP), 28 April 1998 (1998-04-28) abstract; figures ----	1-63
A	DE 42 05 390 A (POLYGRAM RECORD SERVICE GMBH) 26 August 1993 (1993-08-26) the whole document ----	1-63
A	DE 198 27 124 A (LEYBOLD SYSTEMS GMBH) 23 December 1999 (1999-12-23) abstract; claims 1-4; figures ----	1-15, 30-42
A	WO 97 28924 A (MC FADDEN DAVID G ;MC FADDEN GEORGEANN (US)) 14 August 1997 (1997-08-14) page 4, line 2 -page 8, line 9; figures ----	1,11-23, 30, 38-49, 56-63
A	US 5 593 343 A (BAUER JASON) 14 January 1997 (1997-01-14) abstract; claims 1-12; figures ----	1,16-21, 30, 43-47, 56-63
P,X	EP 1 040 900 A (TOMOAKI ITO) 4 October 2000 (2000-10-04) the whole document -----	1-63

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 01/00644

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5220754	A	22-06-1993	NONE	
DE 4340595	A	01-06-1995	NONE	
JP 09309066	A	02-12-1997	NONE	
US 5619898	A	15-04-1997	WO 9406608 A	31-03-1994
			AU 2557192 A	12-04-1994
			DE 4123199 A	21-01-1993
			DE 59208254 D	24-04-1997
			EP 0613413 A	07-09-1994
			HU 66226 A,B	28-10-1994
			JP 7504860 T	01-06-1995
			JP 3088753 B	18-09-2000
EP 0794528	A	10-09-1997	US 5915915 A	29-06-1999
			JP 10011747 A	16-01-1998
			SG 47211 A	20-03-1998
			US 5984619 A	16-11-1999
JP 10109241	A	28-04-1998	NONE	
DE 4205390	A	26-08-1993	WO 9316855 A	02-09-1993
DE 19827124	A	23-12-1999	NONE	
WO 9728924	A	14-08-1997	NONE	
US 5593343	A	14-01-1997	AU 5441196 A	23-10-1996
			US 5954566 A	21-09-1999
			WO 9631316 A	10-10-1996
			US 5733179 A	31-03-1998
EP 1040900	A	04-10-2000	JP 2000280247 A	10-10-2000